Hydrocarbon gas sensing with perovskite structured SMOX materials

B. Junker[1], A. Alharbi[2], U. Weimar[1] N. Bârsan[1]

[1]*Institute of Physical and Theoretical Chemistry (IPTC), University of Tübingen, Auf der Morgenstelle 15, 72076 Tübingen, Germany*

[2]*National Center for Nanotechnology and Semiconductors, King Abdulaziz City for Science and Technology (KACST), Riyadh 11421, Saudi Arabia*

benjamin.junker@ipc.uni-tuebingen.de

Perovskite structured materials have attracted a lot of interest in gas sensor research and numerous possible combinations of elements and molecules with unique properties are reported in literature [1]. In contrast to many other gas sensors based on binary semiconducting metal oxides (SMOX), a clever selection of elements could offer sensors with high selectivity without noble metal loading or doping.

Gas sensors based on $LaFeO_3$ show a high response to the hydrocarbons acetylene and ethylene at low operating temperatures in dry and humid conditions. To understand the role of the different metal ions in the gas sensing process, their sites in the ABO_3 perovskite structure were populated by different elements. The variation of the lanthanoid ion is maintaining the overall sensing properties of the compound, but influences parameters such as selectivity, resistivity and response time. A substitution of the smaller Fe^{3+} ion at the B-site by other transition metal ions severely decreases the performance of the sensing material and yields much different chemical and physical properties [2]. Detailed investigations using diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS) revealed, that incomplete combustion of hydrocarbons enables the formation of different surface species, out of which formates play a key role in the gas sensing process [3]. Recent studies on different materials indicate, that the sensing mechanism on $LnFeO_3$ gas sensors not only changes with different target gases, but is also influenced by temperature, background humidity, and gas concentration.

ABO_3	La	Sm	Gd
Cr	$LaCrO_3$	$SmCrO_3$	$GdCrO_3$
Mn	$LaMnO_3$		
Fe	$LaFeO_3$	$SmFeO_3$	$GdFeO_3$
Co	$LaCoO_3$	$SmCoO_3$	$GdCoO_3$
Ni	$LaNiO_3$		

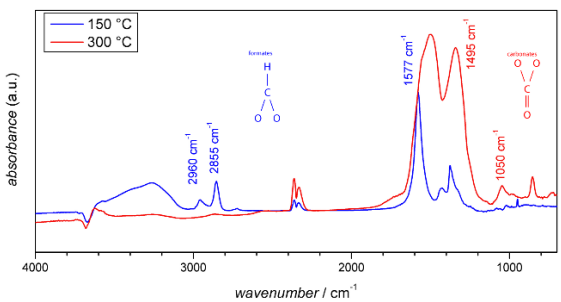

Fig. 1. Left panel: Investigation of different element combinations in ABO_3 perovskites, starting from well-known $LaFeO_3$. Right panel: DRIFT spectra of $SmFeO_3$ exposed to 500 ppm ethylene at different temperatures.

[1] M. Shellaiah and K. Wen Sun, Chemosensors 2020, 8, 55.
[2] A. Alharbi et al. Sensors 2021, 21(24), 8462.
[3] A. Alharbi et al, J. Phys. Chem. C 2020, 124, 7317–26.